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to Alaska. The seeds are said by Dr. J. S. Newberry to form the principal winter subsistence of the Indians.

5. *N. sagittifolium* PURSH.—Flowers small, about an inch across when expanded: sepals 5: petals dilated upward, about 3 lines long by $1\frac{1}{2}$ wide: stamens 4 or 5 rows; the anthers about $\frac{1}{2}$ their length: stigmas 11–15 ridges on a disk with crenate margins: fruit ovoid, without a neck under the disk, the largest an inch in length: leaves olive-green, smooth, oblong, rarely ovate, broadly obtuse at the apex, sagittate, the sinus $\frac{1}{10}$ the length of the leaf; the floating varying from 8 to 15 inches long by 2 to 3 broad; the submerged larger and more numerous: the petals sometimes transformed into stamens.—PURSH, 370.

Confined to the Southern Atlantic States from North Carolina to Florida.

EXPLANATION OF PLATE VI.—The figures are drawn from herbarium specimens and are enlarged one-third.

1. Sepal of *N. advena*. 2. Two forms of petals of same, both common, one showing the nectary on the back. 3. Stamen of same. 4. Stigmatic disk of same. 5. Sepal of *N. rubrodiscum*. 6. Two forms of petals of same, both common, one showing the nectary. 7. Stamen of same. 8. Stigmatic disk of same. 9. Petal and stamen of the European *N. luteum*. 10. Sepal of *N. Kalmianum*. 11, 12, 13. Petals, stamen and stigmatic disk of same. 14, 15. Petals and stamen of the European *N. pumilum*. 16. Fruit of *N. rubrodiscum*. 17. Fruit of *N. Kalmianum*, one of the berries oblique, as is frequently the case in all the species. 18. Fruit of *N. advena*.

Grasses of Yellowstone National Park. I.

F. LAMSON SCRIBNER AND FRANK TWEEDY.

The following grasses were collected by Mr. Tweedy, of the U. S. Geological Survey, during the seasons of 1884–85, and he has also furnished the notes upon the distribution of the species. Sets of the grasses here enumerated were sent to Dr. Asa Gray, to the Academy of Natural Sciences of Philadelphia, and to the U. S. Department of Agriculture.

1. (263, 580.) *PANICUM DICHOTOMUM* Linn. var. *PUBESCENS* Gray, Man. p. 649. *P. pubescens* Lam., Michx. Flor. 1.49; Torr. Flor. U. S. 144; Steud. Gram. 86. *P. thermale* Boland. Proc. Calif. Acad. II, p. 181. Very common over the hot spring and geyser areas, often forming matted, carpet-like masses around the borders of the springs themselves.

This variety should perhaps be kept distinct from *P. dichotomum* L., but until a more thorough study can be given the interminable diversity of forms presented by the *P. dichotomum* of American authors, and careful comparisons made with the types of the species founded by Lamark, Kunth and others, any attempt to classify them will be worse than useless.

2. (579.) PHALARIS ARUNDINACEA Linn. (Coulter's Manual, p. 40). Bogs, Yellowstone Lake, rare.

3. (648.) HIEROCHLOA BOREALIS R. & S. (Coulter, Man. 406).—Mountain meadows from 8000 to 9000 ft. alt., not common.

4. (591.) ALOPECURUS OCCIDENTALIS, n. sp.—“*A. pratensis*, var. *alpestris* Wahl. (*A. glaucus* Less.) ex Gray,” Thurber in list of Hall and Harbour's Rocky Mountain plants. *A. alpinus* Porter and Coulter, Flor. Col. p. 251; Coulter, Man. p. 406.

A tall erect grass, usually glaucous throughout, with thick ovoid heads. Stems 60–90 cm. (or, in very dry soil, 20–30 cm.) high, erect, sheaths smooth or finely scabrous, much shorter than the internodes, loose, at least the upper ones, but not inflated. Ligule 1–2 mm. long. Leaves erect or ascending, 5–15 cm. by 4–7 mm., flat except at the cartilaginous and sharply pointed apex, smooth beneath, scabrous on the prominent nerves above. Panicle usually long exserted, sometimes partially enclosed in the upper sheath, 2–3 cm. long and half as thick. Spikelets 3.5–4.5 mm. long (usually about 4 mm.), the rather abruptly acute empty glumes equaling or slightly exceeding the obtuse flowering glume, which is scabrous and more or less ciliate near the tip. Awn about 6 mm. long, smooth and twisted below, more or less bent near the middle, scabrous above.

Mirror Lake Plateau, alt. 8800 ft. Rather common in mountain meadows, associated especially with *Phleum alpinum* L. In similar situations in Montana this grass is not infrequent, sometimes covering large areas to the exclusion of other species. In the mining regions it is cut for hay, for which purpose it is highly esteemed under the name of “mountain timothy.”

I have seen no specimens of *Alopecurus glaucus* Lessing, but our grass certainly does not agree with the diagnosis of that species given by Grisebach in Ledeb. Flor. Ross. IV, p. 462, nor in all respects with that of Steudel in Syn. Gram. p. 150. It is a much taller plant than *A. alpinus* Sm., to which it is most nearly allied, and besides its glaucous color and more rigid foliage, the hairiness of the glumes is less woolly in character, and the awn is always more developed. The true *A. alpinus* has not yet been found within our limits. The plant in question differs from *A. pratensis* in its shorter and more ovoid spikes, more hairy, less conspicuously nerved and shorter empty glumes, and in the comparatively shorter and more obtuse flowering glume. *Alopecurus arundinaceus* Poir. (*A. ruthenicus* Weinm., *A. nigricans* Hornem.), a species which our plant resembles in habit, has a more cylindrical spike, and differs especially in having the acute tips of the less hairy empty glumes curved outwards, and further also in the much shorter awn.

5. (592.) *ALOPECURUS GENICULATUS* Linn., var. *ARISTULATUS* Torr. Flor. U. S. p. 97, Niccolet's Rept. p. 163. *A. aristulatus* Mx. Flor. I, p. 43; Gray, Man. p. 608; Coulter, Man. p. 407. Wet shores of ponds and banks of streams. Cache Creek, alt. 6800 ft., Turbid Lake alt., 7900 ft.

Although ranked as a species by most American authors, we are disposed to consider this grass a variety only of the Linnæan species. The points of difference are its usually more erect habit, more slender spikes or rather panicles, smaller spikelets and generally shorter awn. In these particulars it is essentially *A. fulvus* Smith. In *A. geniculatus* the spikelets are about 3 mm. long and the outer glumes are usually *longer* than the floret; in the variety the spikelets are scarcely more than 2 mm. long while the flowering glume is as long as or slightly exceeds the outer ones. The awn varies from being nearly obsolete to twice the length of the spikelet.

6. (262, 609, 613.) *STIPA VIRIDULA* Trin., Act. Petrop. 1836, p. 39; Thurber in S. Watson's Bot. Calif. II, p. 288. *S. parviflora* Nutt. not Desf. *S. spartea* Hook. Fl. Bor.-Am. II. 237, not Trin. (*teste* Thurber.)—Meadows, Mammoth Hot Springs, alt. 6200 ft., Sour Creek, alt. 8000 ft., junction of the East Fork and Soda Butte Creek, alt. 6700 ft. Common everywhere over the dry open areas up to 8000 ft. altitude.

This grass varies a good deal in eight of stem, length of leaves and size of panicle, but it is readily distinguished from the other species of the region by its strict, rather densely flowered and generally elongated panicle, and small spikelets. It is a valuable forage plant, as it does not possess the long and very sharp-pointed rhachilla below the flowering glume which renders *S. spartea* Trin. ("porcupine grass") so injurious to stock.

8. (611.) *STIPA RICHARDSONI* Link. Hort. Berol. 2, p. 245; Coulter, Man. 408.—Soda Butte, alt. 6800 ft., comparatively rare or local. This is a very graceful species with short leaves, slender stems (60–90 cm.) and a nodding purplish panicle of widely spreading few-flowered branches. Spikelets 8–9 mm. long—the length of the lowest glume, which is nearly twice the length of the flowering glume. The latter is thinly covered with short hairs, rests upon a very short and obtuse (or acute) rhachilla, and terminates in a slender, scabrous, once or twice geniculate awn, 12–20 mm. long.

8. (610.) *STIPA COMATA* Trin. and Rupr., var. *INTERMEDIA*. Flowering glume including the rhachilla at the base 15 mm. long, awn about 7 cm., straight beyond the geniculations. A form intermediate between *S. comata* and *S. spartea* but belonging rather to the former.

Junction Butte, alt. 6000 ft., growing with *S. viridula*, but less common.

In both *Stipa spartea* and *S. comata* the rhachilla below the flowering glume is 4–5 mm. long and is densely pubescent except at the very sharp point. In *S. spartea* the usually dark colored flowering glume is of very firm texture, and, excepting for a line of rather stiff hairs near the margins that often extend its whole length, is very smooth and shining above; the awn is very strong and rigid and nearly straight beyond the geniculations. In *Stipa comata* there is no distinct line of hairs on the pale green flowering glume, but its entire outer surface is thinly covered with short silky hairs; the rather slender awn is much elongated beyond the geniculations in the type, and more or less curled. In *S. spartea* the panicle is long exserted, the branches strictly erect and one to two flowered. In *S. comata* the base of the somewhat spreading one-sided panicle is never entirely free from the upper sheath.

The variety named above resembles some forms of *Stipa tigrera* Presl., but in that species the palea is hyaline, and scarcely one-third as long as its glume. There are other characters of difference, but this alone will serve to distinguish the two.

9. (615.) *ORYZOPSIS ASPERIFOLIA* Michx. Fl. 1. 64; Gray, Man. p. 617. (Not in Coulter's Manual.)

Pine woods, Soda Butte creek, rare.

10. (614.) *ORYZOPSIS EXIGUA* Thurber in Botany of Wilkes' Exped. p. 481. (Not in Coulter's Manual.)

On rocky bare knolls along Slough Creek; alt. 6700 ft. Not seen elsewhere.

This is a densely tufted grass with slender wiry stems 15–25 cm. high. It has much the habit and appearance of *Oryzopsis Canadensis* Torr., but differs essentially in its simple and contracted panicle, its shorter outer glumes, and in its longer and somewhat persistent awn.

11. *ORYZOPSIS CUSPIDATA* Benth. Jour. Linn. Soc. XIX, p. 82; Coulter, Man. 410. *Eriocoma cuspidata* Nutt. Gen. I, p. 40. *Urachne lanata* Trin. Panic. p. 126.—Sparingly scattered over the low and dry open areas.

12. (649.) *PHLEUM ALPINUM* Linn.; Coulter, Man. 410.—Bogs and meadows, common between 8000 and 9000 ft. altitude.

13. (590.) *SPOROBOLUS DEPAUPERATUS* Scribn. in Torr. Bull. IX, p. 103. *Vilfa depauperata* Torr. in Hook. Flora Bor.-Am. II, 257, t. 236.—Common about Yellowstone Lake.

14. (605.) *AGROSTIS VARIANS* Trin. Agrost. II. 68; Thurber in S. Wats. Bot. Calif. I, p. 273. (Not in Coulter's Manual.)—Bogs, Mirror Lake plateau, common.

15. (258, 606, 607, 608.) *AGROSTIS SCABRA* Willd.; Coulter, Man. 412.—Meadows and dry slopes, very common up to alt. 8000 ft.

The more common form of the species is represented by no. 258. No. 607 is a low (10–20 cm.) densely cespitose form with short and subulate radical leaves (*Trichodium subulatum* Nutt. in Herb. Phila. Acad.). No. 606 is an unusual form, and is referred to *Agrostis scabra* only after very careful comparisons and examinations. It has the rather short and very narrow radical leaves and the characteristic spikelets of that species, but the cauline leaves are comparatively broader and longer, especially the uppermost one, and the panicle is also narrower and apparently more densely flowered. The panicle is 6–10 cm. long, with 3–5 unequal (1–5 cm.) branches at each joint which, with the pedicels, are not so decidedly scabrous as in the type.

16. (604.) *AGROSTIS EXARATA* Trin. *Agrost.* II. 87; Thurb. in S. Wats. Bot. Calif. II. 273; Coulter, Man. 412.—Wooded bogs and along mountain streams, not common.

The specimens distributed were gathered near Pelican creek, alt. 8000 ft. They differ considerably from the type as figured by Trinius (*Icones* t. 27), but the limits of the species are not clearly understood, a great variety of forms having been referred to it, this along with others.

17. (259, 603.) *AGROSTIS HUMILIS* Vasey in Torr. Bull. X, p. 21. (Not in Coulter's Manual.)

Cool mossy bogs and mountain meadows, alt. 7000–9000 ft., rather common.

This very well marked and pretty little species, has the rachilla produced behind the palea into a short naked bristle, a character not noted in the original description. (It is No. 671 Hall & Harbour.)

18. (581.) *CINNA PENDULA* Trin. *C. arundinacea* L. var. *pendula* Gray; Coulter, Man. 413.—Wooded bogs and streams, East Fork, alt. 8600 ft., not common.

This species is at once distinguished from *C. arundinacea* by its smaller (4 mm. or less) spikelets and equal or nearly equal outer glumes. In many specimens examined, both from New England and from the northwest, we have found the rachilla prolonged behind the palea into a short naked bristle. Mr. Tweedy collected in Washington Territory a variety (var. *glomerula* Scribn. Proc. Acad. Phila. 1884, p. 290) with the spikelets arranged in small dense clusters or little glomerules along the extremities of the branches of the very diffuse panicle. The spikelets were scarcely more than 2 mm. in length, with very narrow acuminate-pointed empty glumes.

19. (248.) *DEYEUXIA LANGSDORFFII* Kunth, Gram. I. 77, Enum. Pl. I. 243; Hooker Arc. Pl. 307 & 345; Coulter, Man. 413. *Calamagrostis Langsdorffii* Trin. Gram. Uni-Sesquifl. 225; Gray, Proc. Am. Acad. IV. 77, Manual, 615; Thurb. in S. Wats. Bot. Calif. II. 279. (To this species is referred *Deyeuxia purpurea* Kth., which name should, perhaps, take precedence.)—Common in wooded and open mountain meadows and bogs, alt. 7000–9000 ft.

The specimens are exactly like the eastern plant with the awn attached considerably below the middle of glume which it equals or slightly exceeds. The leaves are much narrower than the ligule, which is 5–8 mm. long, more or less scabrous and remarkable for being strongly nerved.

20. (584.) *DEYEUXIA CANADENSIS* Hooker, Arc. Pl. 307 & 345; Coulter Man. 413. *Arundo Canadensis* Michx. Fl. I. 73. *Calamagrostis Canadensis* Beauv. (not Nutt.); Gray, Man. 615. *Calamagrostis Mexicana* Nutt. Gen. I. 46. (The *C. Canadensis* of Nuttall is *Deyeuxia Nuttalliana*.)—Common with the last.

The specimens represent a slender form with rather smaller spikelets than usual and more acute glumes. Flowering glume about 2.5 mm. long, deeply bifid and terminating in two very slender awn-like teeth. Awn attached at or a little above the middle. Palea scarcely half as long as its glume.

21. (585.) *DEYEUXIA DUBIA*, n. sp.—Empty glumes between 3 and 4 mm. long, lanceolate or oblong-lanceolate, either gradually tapering to the apex or abruptly acuminate, finely scabrous on the back above. Flowering glume nearly as long as the empty ones, bifid at the apex and irregularly 4-toothed by the prolongation of the prominent lateral nerves, minutely scabrous above the middle below which is attached the straight and rather stout awn that equals the outer glumes in length. Palea a *very little* shorter than its glume, distinctly 2-nerved, irregularly 2-toothed. Hairs on the rachilla below the glume scanty and short behind, more abundant at the sides and $\frac{2}{3}$ – $\frac{3}{4}$ the length of the glume.

A tall (60–90 cm.) grass with the foliage and habit of *D. Canadensis* or *D. Langsdorffii*, but differing from both in the less spreading and more densely flowered branches of the panicle, the stouter branches at each joint flower-bearing to the base. From *D. Canadensis* this species is at once distinguished by the longer and stouter awn, shorter hairs surrounding the flowering glume and firmer and longer palea. The spikelets are smaller than in *D. Langsdorffii*, the empty glumes are much smoother and less rigid or firm in texture, the hairs are less copious as well as shorter and the palea is proportionately longer.

Meadows, Slough Creek, alt. 6700 ft. (= no. 365 Scribner,

Montana collection. Found in open woods, Elk Creek, near Ft. Logan, alt. 5500 ft., July 25.)

21. (253, 582, 583.) *DEYEUXIA NEGLECTA* Kth. Gram. I. 76, Enum. Pl. I. 242. *Calamagrostis stricta* Beauv. (1812), Trin. Gram. Uni-Sesquifl. 226; Gray, Proc. Am. Acad. IV. 78; Thurb. in S. Wats. Bot. Calif. II. 282 *Deyeuxia stricta* Coulter, Man. 414 (not HBK.)

Dry meadows and slopes between 7000 and 9000 ft. altitude. So far as observed this species affects drier situations than the other species of the genus here named.

This species is distinguished by its rather rigid, erect and few (2, rarely 3) jointed stems, narrow rigid and usually erect leaves, strict and densely flowered panicle—often spike-like above, lobed and more or less interrupted below—the spikelets being crowded on short, usually appressed compound branches. The leaves of the sterile shoots are always very narrow and attain to one-half or two-thirds the height of the culm (their length is in marked contrast with the rather short leaves of the latter). No. 582 is a slender form (that may be designated as var. *gracilis*), 30–40 cm. high, with 3–4 stem leaves, the sheaths of which equal or much exceed the joints, and a narrow but rather loosely flowered panicle. The outer glumes are narrower and more pointed, less firm in texture and not so rough as in numbers 253 and 583. It is certainly of the same species, however.

Some of our specimens differ from the European plant in the more scabrous and firmer glumes, a difference that is by no means constant. *Calamagrostis confinis* Nutt. is too near this species to be kept distinct, and the same is probably true of *Calamagrostis crassiglumis* Thurb., which represents an opposed extreme in development. None of our forms of *Deyeuxia neglecta* exactly correspond with *Deyeuxia Lapponica* Kunth, from Europe. The differences, however, are slight and the two were united by Gen. Munro, the first name being made a synonym of the latter.

22. (616.) *DESCHAMPSIA CÆSPITOSA* Beauv., Agrost. 91, t. 18, f. 3; Coulter's Manual, p. 414. *Aira cæspitosa* L., Gray's Manual, p. 641. Dry and moist meadows and slopes, from 7000–9000 ft. altitude.

Although *D. cæspitosa* Beauv. and *D. flexuosa* Griseb. are at once recognized by one familiar with the two, the former is so variable, particularly in the Rocky Mountain forms, that it is not easy to find a constant character, which can be expressed, to distinguish them. It may be said, however, that in *D. flexuosa* the outer glumes are only 1-nerved (rarely the 2d is obscurely 3-nerved at the base) and much less firm in texture than the flowering ones. In *D. cæspitosa* the 2d (and sometimes also the

1st) glume is distinctly 3-nerved below, and the texture of the outer glumes is usually firmer than that of the flowering ones which are truncate at the apex and irregularly toothed, a character not observed in *D. flexuosa*. The awn in *D. cæspitosa*, usually about the length of the flowering glume, is sometimes quite as long as in *D. flexuosa*. I have never seen the latter species from the region west of the Mississippi.

23. (619.) *TRisetum subspicatum* Beauv.; Coulter's Manual, p. 415.—Common in meadows from 7000–9000 ft. alt., low elevations preferring shaded or more moist situations.

24. (618.) *TRisetum subspicatum* Beauv. var. *MOILLE* Gray.—Common with the preceding.

25. (249,250,617.) *TRisetum Wolfii* Vasey in Bot. Wheeler's Exped. p. 294; Scribner, Torr. Bull. X, p. 64. *Trisetum subspicatum* P. B. var. *muticum* Bolander, ex Thurb. in S. Wats. Bot. Calif. II, p. 296 *Grapphephorum Wolfii* Vasey in Descr. Cat. U. S. Grasses, 55; Coulter, Man. 433.—Moist meadows, generally in the shade, from 7500–9000 ft. alt., rather frequent. Associated with *Deyeuxia Canadensis*, *Bromus ciliatus*, etc.

The relationship of this grass to *Grapphephorum melicoides* P. B., was indicated by Dr. Vasey in Wheeler's Report, and at that time he questioned whether it might not prove identical with that species, but more recent and better material has fully established its specific rank. It differs in having rather stouter and more rigid stems, a more densely flowered and erect panicle, more nearly equal outer glumes and in the comparatively longer paleæ. In later publications this species has been referred to the genus *Grapphephorum*, but the only character—the very short or nearly obsolete awn—by which it has been separated from *Trisetum*, is one of no generic value in itself. The fact that the flowering glumes are entire or merely obtusely two-lobed at the apex has no special significance as we not infrequently find the flowering glumes in *T. subspicatum* terminating similarly. The plant in question has in all respects—stem, leaves and inflorescence—the habit of *T. subspicatum*, and although a careful examination of the spikelets reveals its specific distinctions, it is not at all surprising that it should have been made a variety of that species. *Trisetum Brandegei* Scribn. (Torr. Bull. X, p. 64) is only a very robust form of *T. Wolfii* with 3–4 flowered spikelets.

26. (612.) *AVENA STRIATA* Michx.; Gray, Man. 640; Coulter, Man. 415. Wooded moist meadows and swamps, Slough creek, alt. 6800 ft., Soda Butte creek, alt. 7200 ft. Rather rare.

There is another *Avena* which may also occur within the park, as it is not infrequent in the mountain districts of central

Montana. It is distinguished from *A. striata* by its rigidly upright stems, strict, rather densely flowered, erect panicle, and larger spikelets. It is the *Avena versicola* of Hooker (Flor. Bor.-Am.), but certainly not of Villars. It equals no. 372 Scribner, Montana collection, distributed in 1884, under the name of *Avena pratensis* L. var. *Americana*.

Specimens of this grass were communicated to Prof. E. Hackel, of Austria, who states in a letter dated June 27, 1884, that it is a species he had long known, having first received it from European Russia and later from the Ural Mts. and also from the mountains of Altai and Dauria, in Northern Asia. He adds that he did not publish the species because he was uncertain of its specific distinction from *A. pratensis* L. and *A. compressa* Heuff., but at that time he considered it "quite as distinct as most of the species of the group of *pratensis*, which is a very perplexing one and can only be treated monographically."

27. (269, 597.) *DANTHONIA INTERMEDIA* Vasey in Torr. Bull., May, 1883.—Dry and moist meadows, from 7500 to 8500 ft. alt., rather common.

This grass is referred to *D. sericea* Nutt. by Dr. Thurber (S. Wats. Bot. Calif. II. 294), and Prof. Coulter follows him (Man. Rocky Mt. Botany, p. 416), but it is sufficiently distinct from Nuttall's plant and is undoubtedly a good species. Stem and leaves as in *D. sericea* Nutt., but not usually so tall, being rarely over 50 cm. high; the 1-3-flowered branches of the usually shorter (3-5 cm.) panicle, more appressed, and consequently the spikelets are more crowded; the outer glumes are about the same length as those in *D. sericea* (13-16 mm.) but they are fully *twice as broad* and have a different venation, while the flowering glumes are fully twice as large and perfectly smooth excepting along the margins below, as in *D. Californica*, but there are abundant differences separating it from that species.

In central Montana this grass occurs most frequently associated with *Festuca scabrella* at from 6000-8000 ft. alt.

28. (596.) *DANTHONIA CALIFORNICA* Boland. var. *UNISPICATA* Thurb. in S. Wats. Bot. Calif. II, p. 294; Coulter, Man. 415. *D. unispicata* Munro in Herb. *D. monostachya* Nutt. in Herb. Phila. Acad.—Dry rocky open places, Slough creek, rare.

29. (260.) *KÆLERIA CRISTATA* Pers.; Coulter, Man. 418.—Common everywhere in dry situations up to alt. 8000 ft. For notes upon this species see Scribner in Proc. Kansas Acad. Science, p. 117, plate III.

30. (577.) *CATABROSA AQUATICA* P. B.; Coulter, Man. 419.—In water, Gardener's river, alt. 5400 ft. Not seen elsewhere.

31. (268, 601, 602.) *MELICA SPECTABILE* Scribn. Proc. Acad. Nat. Sci. Phila. 1885, p. 45, plate I. f. 11, 12, 13.—Common in rich meadows and on slopes near the upper limits of the bunch grass areas especially at elevations of from 7000–8000 ft.

The difference in habit of growth between *Melica bulbosa* Geyer, and *M. spectabile* Scribner are thus stated by Mr. Cusick: “*M. bulbosa* grows in small tufts while *M. spectabile* is stoloniferous, the underground runners terminated by a small bulb which produces the culm. The runner, I think, soon dies and so the stems become independent, and are never cespitose in the least.”

Outline for study of Chemical Botany.

LILLIE J. MARTIN.

Botanical text-books do not furnish sufficient aid to those desiring to learn to make investigations in vegetable physiology. Students with but a general knowledge of chemistry do not understand the bearing of the microchemical tests given. The result is, that most of the work is mechanical. In fact, any really satisfactory course in chemical botany must be introduced by a short course in organic chemistry. The student who has found out the nature and quantity of the more important constituents of a plant is prepared to trace these substances in its various tissues and even to observe the chemical changes that take place in the process of growth. The outline below, mainly drawn from that proposed by Dragendorff, is an attempt to put this idea into form for class work. No particular plant is suggested, because no one greatly superior to all others yet suggests itself. Corn smut is so rich in products and so easily prepared that at first thought it seemed particularly adapted to such work, but a superficial examination showed that it required too high a power of the microscope to be of value for the microscopical work. Possibly the histological work previously done upon the asparagus and pumpkin vine might make it desirable to use one of these plants.

I. Weigh out five grams of the pulverized plant, burn off organic matter and determine per cent. ash. Make a qualitative examination of half the ash by the method of inorganic chemistry. In the other half determine the amount of some one of the constituents found. Examine ash with microscope to learn if there is anything of a structural nature about it.

II. Weigh out five grams more. Dry at 100° C. until it ceases